Performance of Johnson Matthey EGRT™ Emission Control System for NOx and PM Emission Reduction in Retrofit Applications

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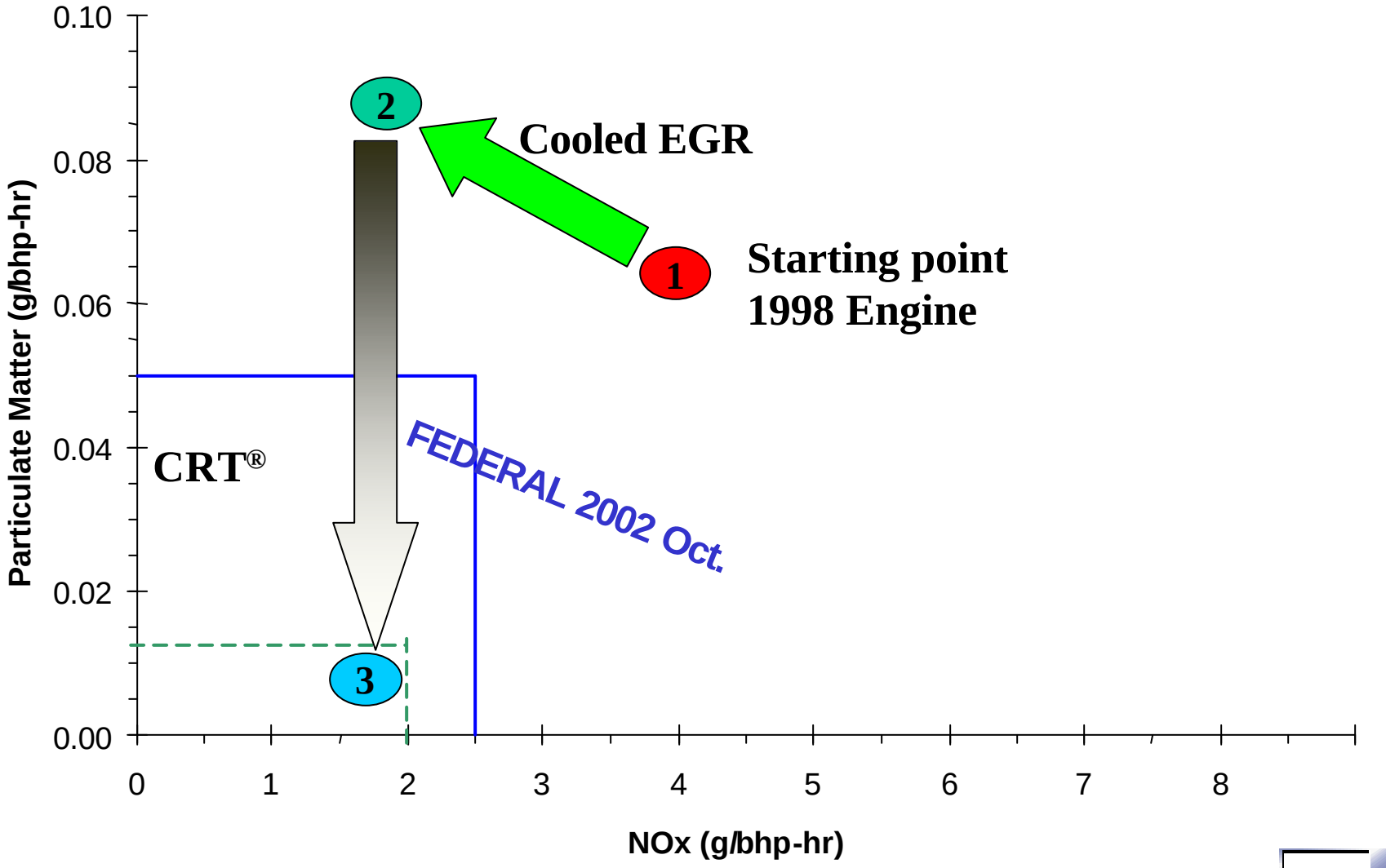
Outline

- Introduction
- System Details
  - CRT Filter System
  - EGR System
- EGRT Applications
  - Emissions Performance
  - On-road Performance
- Conclusions

EGRT™ System

- EGRT™ = EGR + CRT®
- EGR = Re-circulation of part of the exhaust gas to engine air intake
- CRT = Continuously Regenerating Technology Diesel Particulate Filter
- Uses STT patented EGR technology in combination with JM patented CRT particulate filter

Objective of EGRT Retrofit on Current Engines

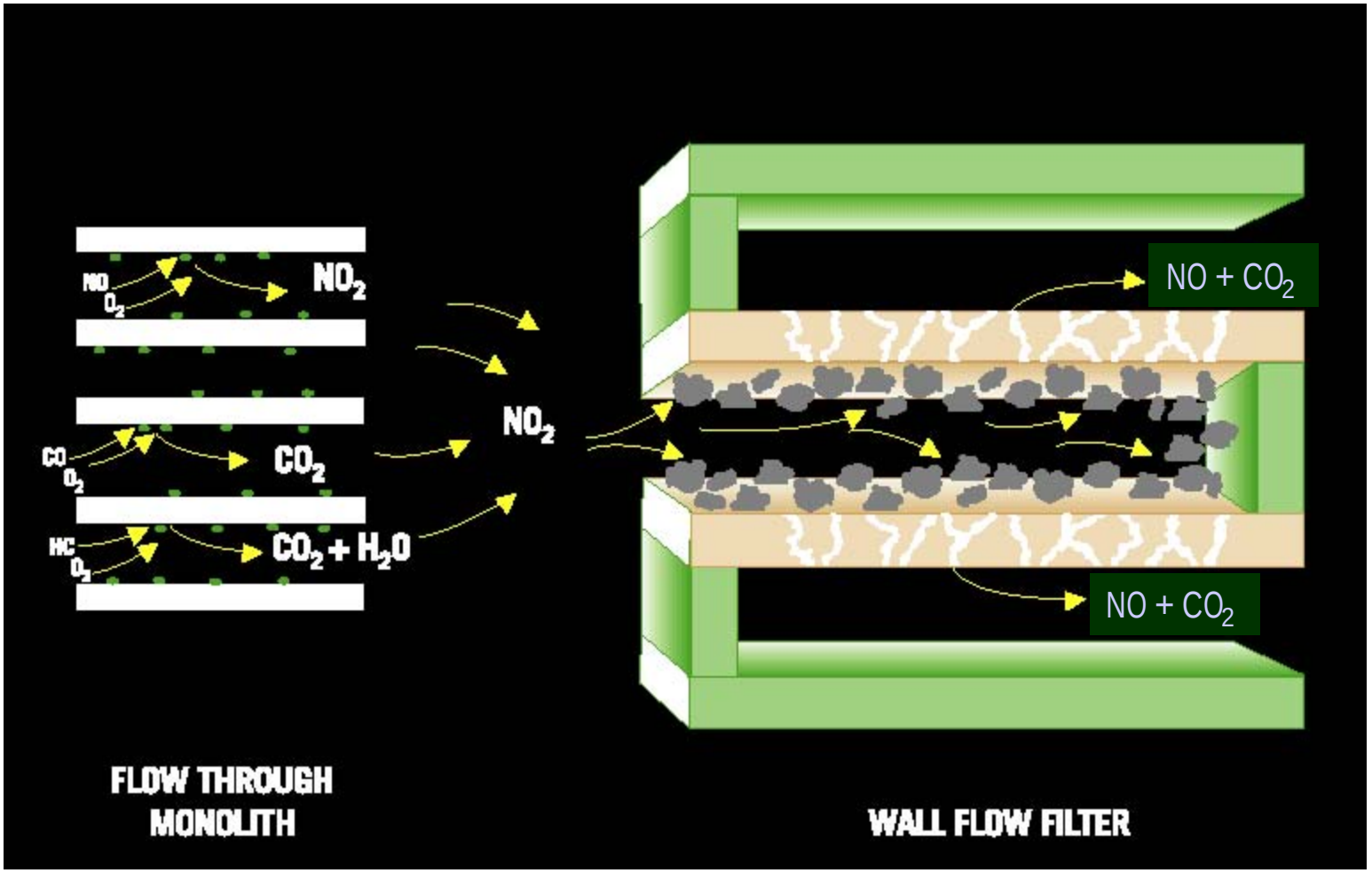


Continuously Regenerating Technology (CRT®)

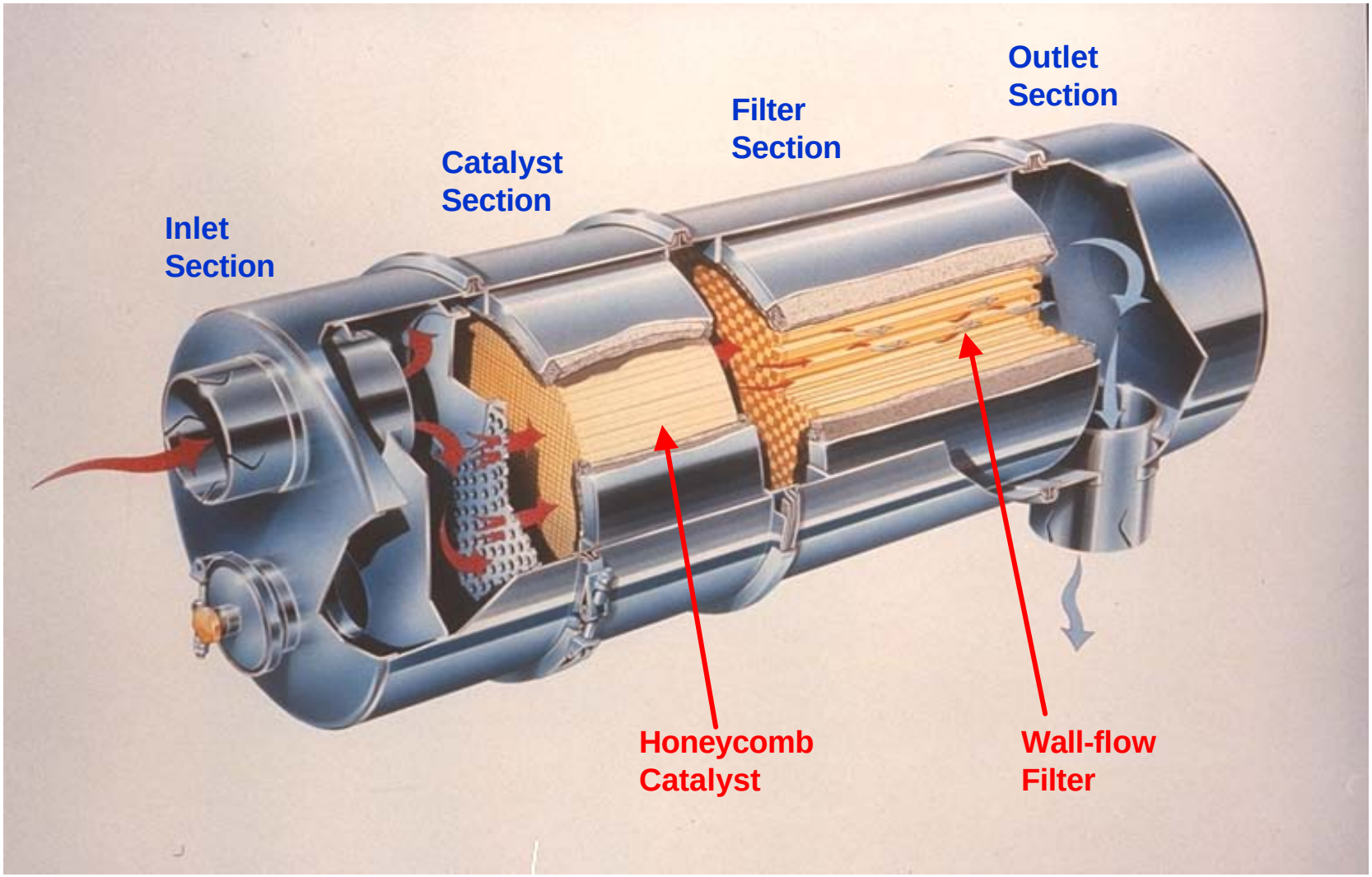
CRT® Particulate Filter for >90% PM Removal

- Patented CO/HC/PM Emission Control System combining Oxidation Catalyst & Filter
- Engineered as a totally passive emission control system which requires no supplemental heat
- Uses NO_2 produced by a specially formulated catalyst to burn soot collected by the filter at typical operating temperatures of diesel engine exhaust
- Requires the use of Ultra Low Sulfur fuel for maximum emission reduction and filter regeneration

NO_2 Reaction in a CRT



CRT® Particulate Filter



Unique Patented Johnson Matthey System

Typical CRT Particulate Filter

Johnson Matthey CRT® System HDD FTP Test Results

	Test Engine			Percent Reduction in Emissions			
No.	**MY**	**Make**	**Model**	**THC**	**CO**	**NOx**	**PM**
1	1995	Cummins	M11	91	89	5	95
2	1999	Caterpillar	3126	88	99	8	88
3	1998	DDC	Series 60	95	94	(2)	87
4	1999	DDC	Series 50	100	72	6	90

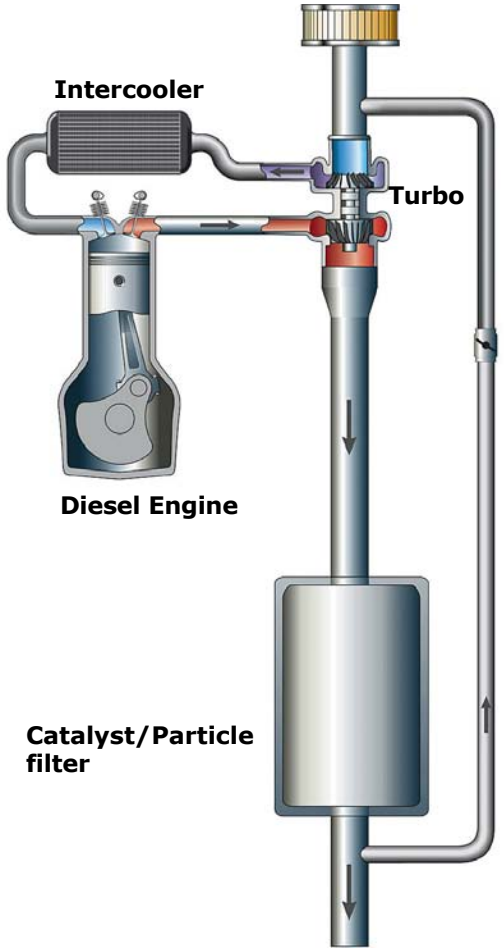
EGR Technology

EGRT System

- EGR - re-circulation of part of the exhaust gas to engine air intake
- Reduced oxygen and increased heat capacity of combustion mixture reduces NOx
- Current system is a low pressure EGR
  - Exhaust flow is taken post CRT filter
  - Reduces PM re-introduction into combustion chamber

Low pressure EGR system

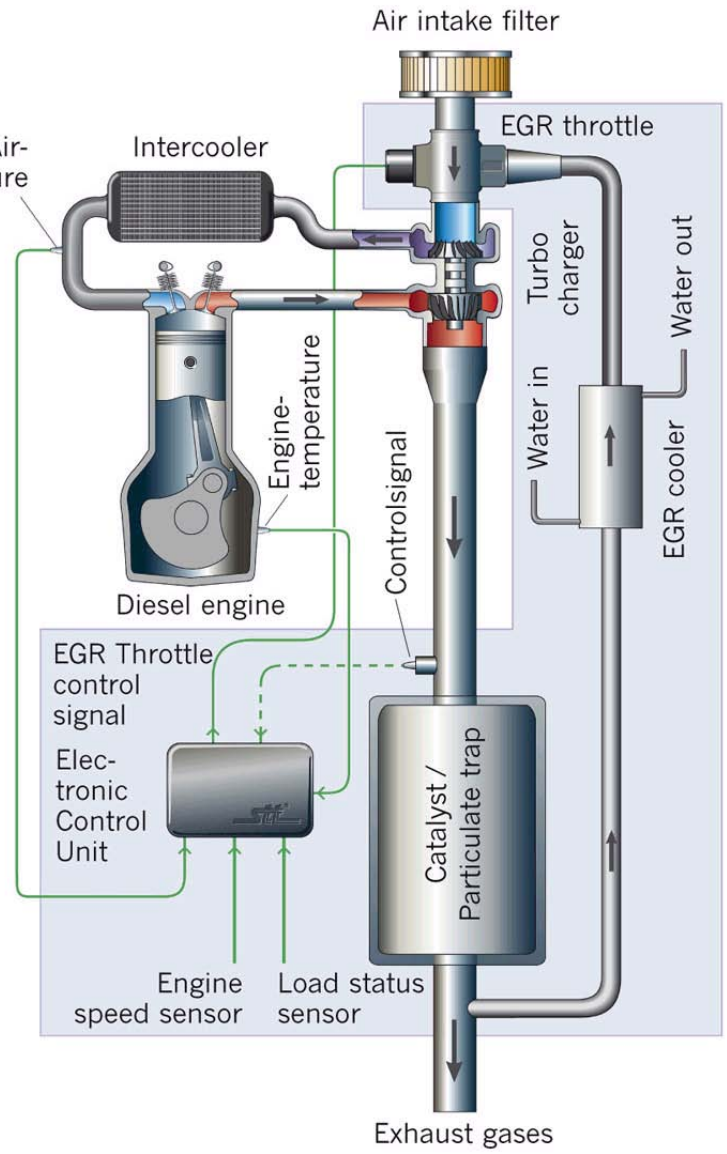
- Good controlability during transient conditions
- High EGR rates achievable under higher loads
- Less complex, better suitable for retrofit applications
- Low cooling capacity
- No engine contamination with soot



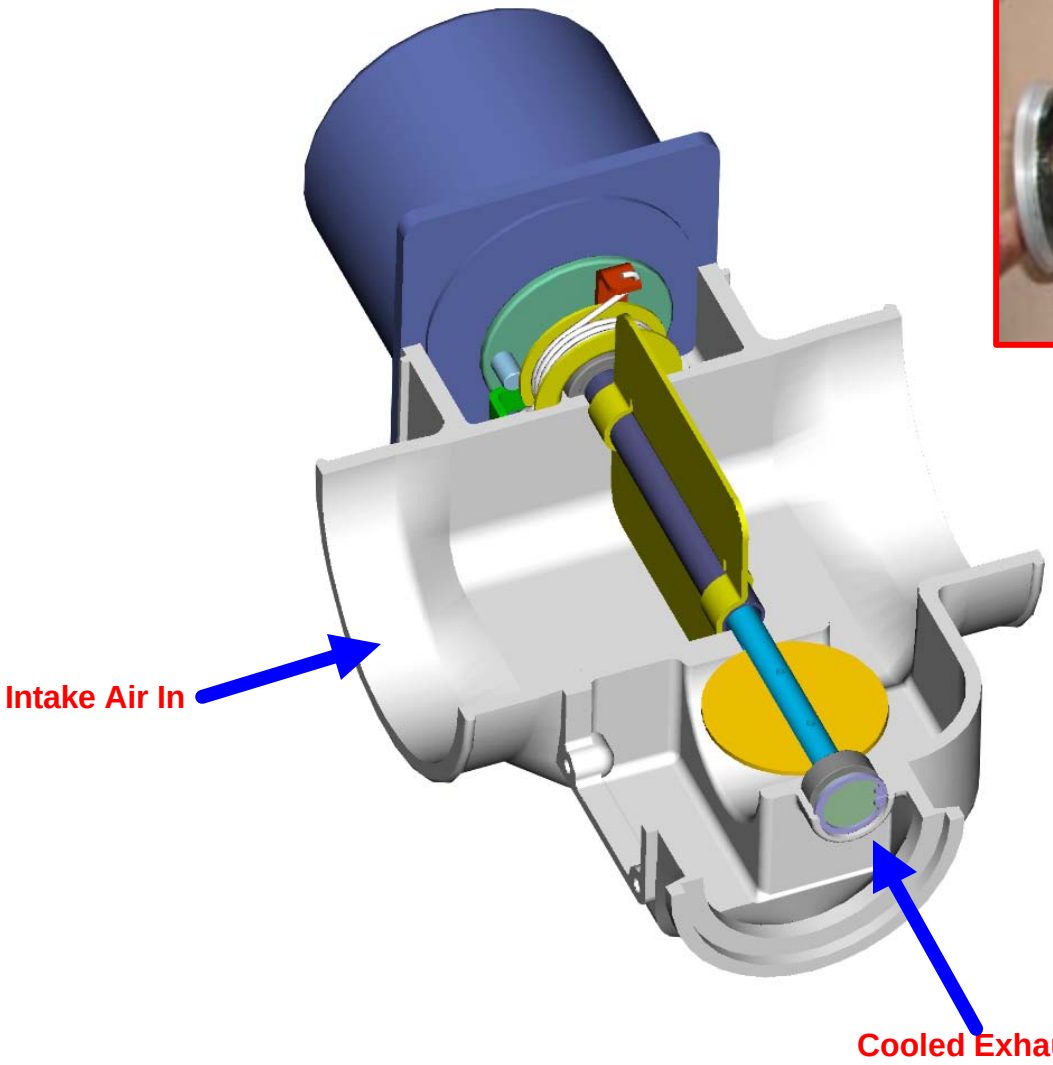
EGRT System

- Low pressure EGR-system with CRT particulate filter
- Used for OEM and retrofit installations
- For trucks, buses, and off-road machinery
- Over 1200 installed on various engines
- Use Ultra Low Sulfur Diesel
- Reduction of legislated emissions

CO	> 90 %
HC	> 90 %
PM	> 90 %
NO_x	> 40 %



EGR Throttle Valve



EGR Control System

Coolant and air inlet temperature

EGR control unit

EGR Throttle valve assembly

Engine ECM

Engine status parameters
Engine speed
Engine load

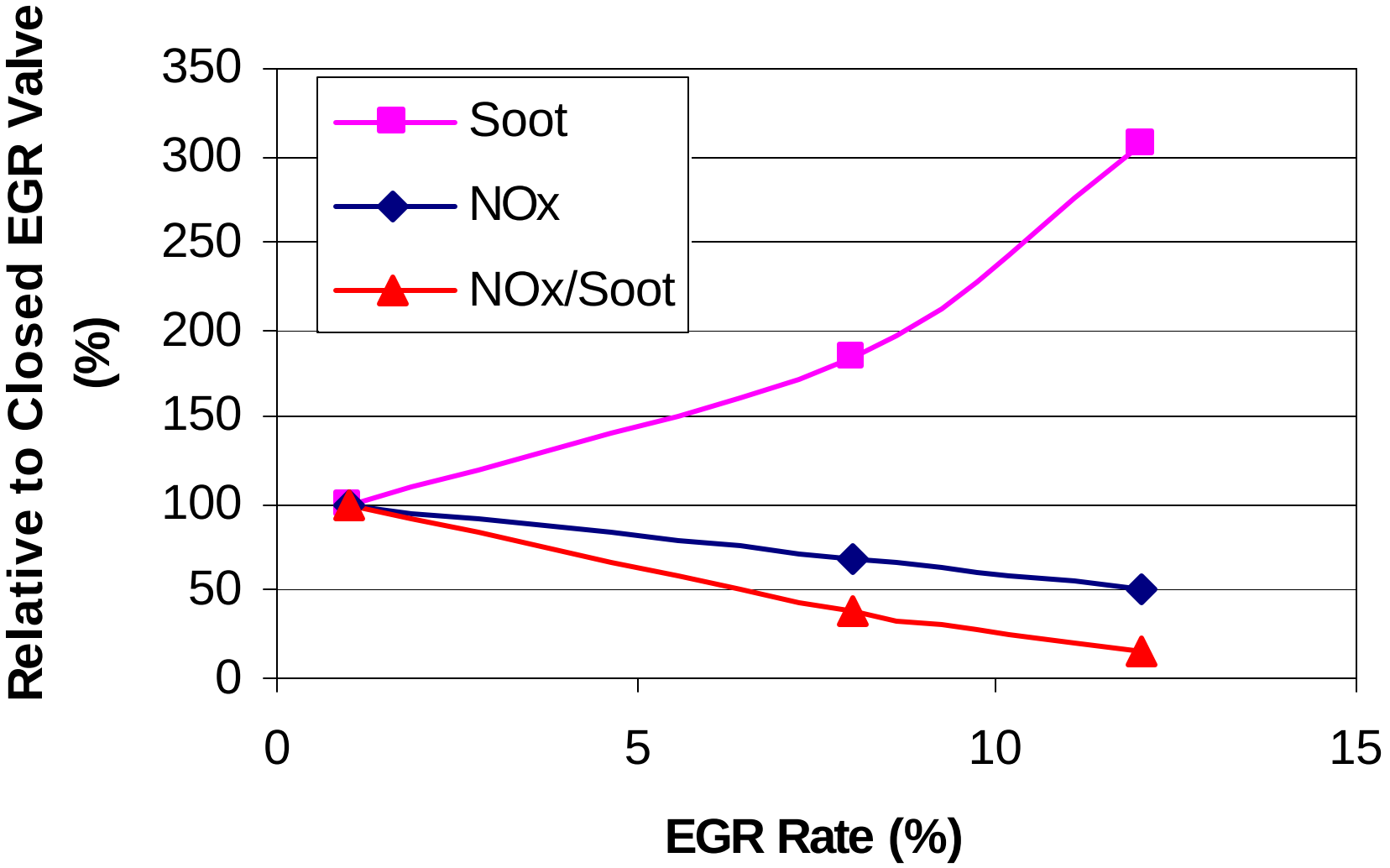
System diagnose LED

CRTdm alarm input

EGR Control Strategy

- EGR Map – Define EGR flow as a function of engine speed & load conditions
- EGR map involves % EGR flow at each speed/load point based on critical parameters
- Critical parameters - opacity, NOx/PM ratio, intake pressure, exhaust temperature
- Develop map based on JM model of CRT and EGR interaction
- Verify map by emissions testing

Effect of EGR on NOx and PM Emissions



EGRT Applications

Worldwide EGRT Applications

- Originally introduced in Sweden in 1998
- Over 1200 units installed in Sweden and Hong Kong
- Over 125,000 miles durability proven on single units
- US introduction 2001
- Demonstration programs on transit buses and dump trucks